Crystal Growth of GaAs using trimethylgallium (TMG) as a Ga source in the MBE system.

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Conventional molecular beam epitaxy (MBE) of III-V compounds is usually done with heated solid sources for the III group and the V group elements. For example, elemental gallium and arsenic are usually used for crystal growth of GaAs. However, there are some disadvantages of these solid sources with regard to convenience and reproducibility. Recently, a few works were reported on the use of AH_3 and PH_3 gases for the group V elements.[1),2)]

In this work, we demonstrated the crystal growth of GaAs by MO-MBE technique using trimethylgallium (TMG) as a gaseous source of Ga and usual elemental arsenic as an As source in the MBE system. The schematic representation of the MBE apparatus used in this work is shown in Fig. 1. It consists of a stainless steel chamber with a 250 l/sec turbo-molecular pumping system. High purity 6N TMG is introduced into the growth chamber through a UHV leak valve and directed towards the substrate.

GaAs epitaxial layers were grown on (100) Cr-doped semi-insulating or undoped n-type substrates. Before crystal growth, the substrate was heated to about 30°C higher than the growth temperature under As_4 flux. The typical growth consitions were as follows: $T_{sub.}$ = 600 -670 °C, T_{As} = 250 - 280 °C, P_{TMG}(partial pressure of TMG) = 5×10^{-6} - 2×10^{-5} Torr. The growth rate was about 0.7 μm/hour at $T_{sub.}$ = 630 °C and P_{TMG} = 2.0×10^{-5} Torr. RHEED diffraction measurements indicated that GaAs epitaxial layers are single crystalline structure as shown in Fig. 2. Epitaxial layers showed p-type and its carrier concentration was about 10^{18} cm^{-3} as typical, which must be due to the residual carbon. It was found from SIMS analysis that the carbon concentration is higher than that of liquid phase epitaxial GaAs films.

In this (TMG, As_4) system, no deposition was observed on the SiO_2 film. This is in contrast with MBE or MOCVD technique where polycrystalline GaAs films grow on the SiO_2 region.[3)] This special feature of the MO-MBE technique must be due to the surface catalyzed growth process. As shown in Fig. 3, monocrystalline GaAs is grown on the GaAs substrate (the window area) but no deposition occurs on the SiO_2 covered area. Growth edges are well defined.

In conclusion, we found the possibility of selective epitaxy of GaAs in the (TMG, As_4) system. This feature will be advantageous for fabricating GaAs integrated circuits and other new devices.

References

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3) A. Y. Cho et al; J. Appl. Phys. 46 783 (1975)

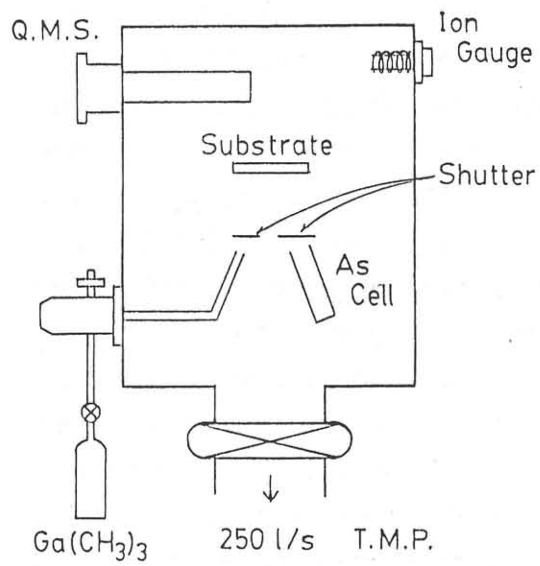

Fig. 1

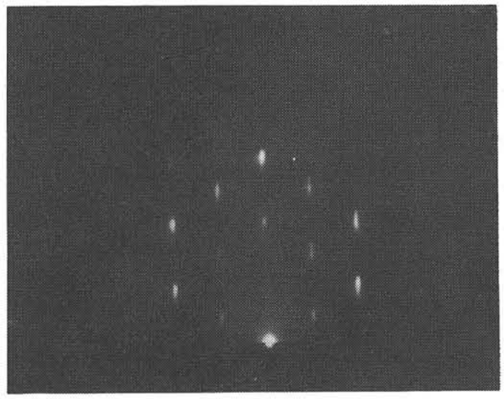

Fig. 2

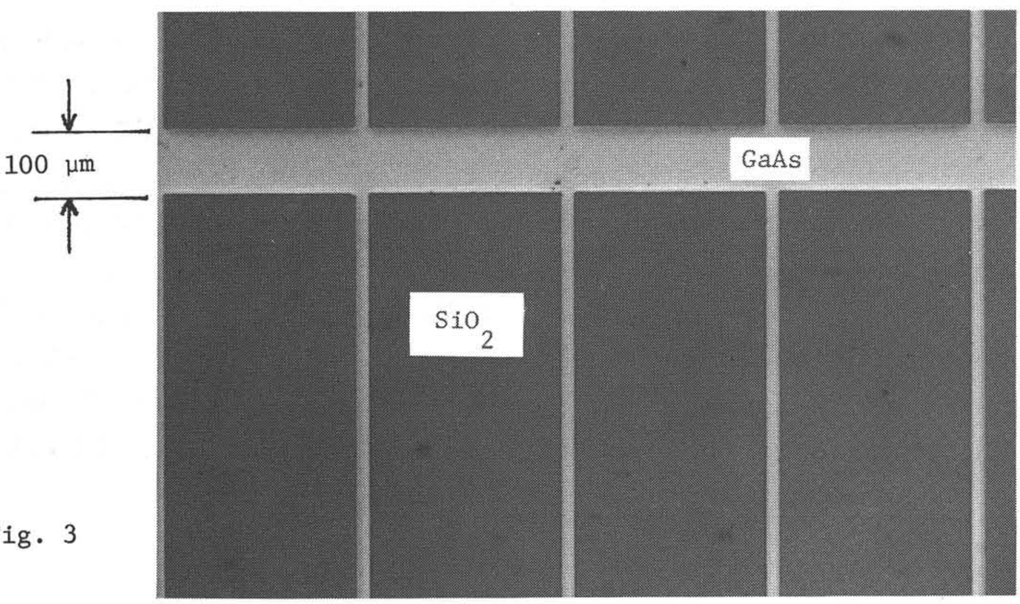

Fig. 3